

## The Decline and Extinction of *Speyeria* Populations Resulting From Human Environmental Disturbances (Nymphalidae: Argynninae)

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**Abstract.** The fritillary butterflies of the genus *Speyeria* and their larval foodplants of the genus *Viola* (Violaceae) are among the best indicator organisms of native, undisturbed ecological communities in North America. They are also among the first organisms to be eliminated from such communities as a result of human-caused disturbances. Thus, many forms of *Speyeria* have greatly declined during the last 200 years, and several local subspecies have become extinct or are threatened with extinction. One such subspecies is *S. zerene hippolyta* (Edwards), which has recently been officially classified as a "Threatened Species" by the U.S. Department of the Interior. This paper presents a discussion of the problems of extinction in *Speyeria* butterflies throughout the United States in general, and reviews the history and problems with *S. zerene hippolyta* in particular.

This paper examines the general problem of declining *Speyeria* butterfly populations due to human environmental disturbances, and the current work to preserve the habitat of *S. zerene hippolyta* (Edwards, 1879), a butterfly officially classified as a "Threatened Species" by the U.S. Fish and Wildlife Service. For this study, samples of *Speyeria* collected in previous years were examined in the collections of the National Museum of Natural History, Virginia Polytechnic Institute and State University, the University of Nebraska, Oregon State University, and the private collections of L. Paul Grey of Lincoln, Maine, and E. J. Dornfeld of Corvallis, Oregon. In addition, field observations were conducted of *S. zerene* (Boisduval, 1852), *S. hydaspe* (Boisduval, 1869), and *S. callippe* (Boisduval, 1852) in Washington, Oregon, Idaho and California from 1960 to 1982, of *S. diana* (Cramer, 1775) in Virginia and Tennessee from 1975 to 1978, of *S. nokomis* (Edwards, 1862) in New Mexico and Arizona in 1976, and of *S. idalia* (Drury, 1773) in Illinois, Iowa and Nebraska in 1978 and 1982. During the field work, the parameters of the habitat including the floral composition and physical aspects were examined, and the probable larval foodplants were identified. The research reported in this paper of *S.*

*zerene hippolyta* was partially funded by the U.S. Forest Service in order to assist the agency in protecting and managing the remaining populations on national forest land, and is based upon the Forest Service reports by McCorkle (1980) and Hammond (1980).

### Decline and Extinction in *Speyeria* Populations

During the past 100 years, biologists and conservationists have become acutely aware of the extermination problems facing many native plants and animals in North America. Of course, the major attention has focused on the decline and extermination of large vertebrate animals such as the Passenger Pigeon, Carolina Parakeet, Whooping Crane, Ivory-billed Woodpecker, and California Condor. Such large vertebrates have declined as a result of over-collecting and the destruction of habitat and food resources. Insects are rarely affected by human over-collecting pressures due to their high reproductive capabilities, but are extremely sensitive to the destruction of their habitat and food resources (Pyle, Bentzien & Opler, 1981). The Diana Fritillary (*Speyeria diana*) of the southern Appalachians is a prime example of this. This butterfly is extremely popular with amateur butterfly collectors, but extensive collecting in parts of western Virginia for many years has not had a noticeable impact upon the populations. Instead, the drastic decline of *S. diana* during the past 200 years was largely due to the destruction of the old-growth hardwood forests in the low valleys and bottomlands for timber and agriculture (Clark & Clark, 1951). Today, the *S. diana* populations in the Appalachians appear to be quite healthy and may actually be expanding with the regrowth of the hardwood forests (Hammond observations, 1975-78).

The general American public and even many biologists with applied orientations often do not realize how extremely complex and intricate natural communities and ecosystems really are, and how extremely sensitive such systems are to human disturbances. Completely virgin, undisturbed ecological communities support a great diversity of native plants and insects. However, as human disturbance of the communities increases, the diversity of species in the communities rapidly decreases. Such activities as agriculture, extensive overgrazing by livestock, extensive forestry management for increased timber production, and suburban development are extremely destructive to natural ecological systems, and can quickly eliminate most of the native plants and insects.

The fritillary butterflies of the genus *Speyeria* and their larval food-plants, violets (*Viola*), are among the most sensitive organisms in native ecosystems, and are among the first to be exterminated as a result of widespread human disturbance. Illustrative of this is the Regal Fritillary (*S. idalia*) and its larval foodplant, the Blue Prairie Violet (*V. pedatifida* Don). These organisms are two of the most characteristic indicator species of virgin tall-grass prairie in the central United States (Hammond

observations, 1978 and 1982). Like the American Bison, it is quite evident that millions of *S. idalia* must have swarmed across the vast expanses of the original tall-grass prairies in Illinois, Iowa, Missouri, Kansas, Nebraska, South Dakota and North Dakota before Europeans eliminated this native ecosystem with agriculture. Today, the violet and butterfly are mainly confined to the few small patches of virgin prairie that still survive in these prairie states, and are being preserved by state and private agencies.

*Speyeria nokomis* is a second species that has suffered serious decline in the southwestern United States due to human disturbances. The species appears to be very tightly restricted to wet, boggy meadows that have a permanent source of water throughout the summer (Hovanitz, 1970; Ferris & Fisher, 1971). Such habitats are naturally scarce in the arid Southwest, and are frequently destroyed by livestock overgrazing and water diversion. For example, meadows observed in the Sacramento Mountains of New Mexico and White Mountains of Arizona were heavily impacted by excessive livestock grazing during 1976. Likewise, the Owens Valley in Inyo County, California, has lost much of its natural water flow as a consequence of water diversion to the City of Los Angeles. Although no subspecies of *S. nokomis* appear to be in danger of extinction at the present time, the colonies are certainly far less abundant than in the past. In addition, the Mexican subspecies *S. nokomis caeruleascens* (Holland, 1900) may now be extinct within the United States with the apparent loss of the Mt. Lemmon colony in Pima County, Arizona (Wielgus, 1973). There is also some concern regarding the status of *S. nokomis wenona* dos Passos & Grey 1945 of Nuevo Leon, Mexico, since this distinctive subspecies has apparently not been found in many years despite several expeditions to its habitat (McCorkle observations, 1972 and 1981).

Even very common species in widely ubiquitous habitats are heavily affected by various types of disturbance. For example, *S. hydaspe* is the primary species of *Speyeria* found in old-growth conifer forests in the Pacific Northwest. However, the timber harvest method of large clear-cuts has steadily replaced the old-growth forests with young, brushy second-growth forests during the past twenty years, steadily reducing the available habitat for *S. hydaspe* as a consequence.

Likewise, both *S. callippe harmonia* dos Passos & Grey 1945 and *S. zerene platina* (Skinner) 1897 are very common species in the sagebrush communities of the arid lowlands east of the Cascade Range. Observations made near Soda Springs and Montpelier, Idaho during 1971 and 1982 revealed a dramatic contrast between undisturbed rangelands and those heavily grazed by livestock. The ungrazed areas supported a rich diversity of herbaceous plants including the Sego Lily (*Calochortus nuttallii* T. & G.), penstemons (*Penstemon* spp.), Indian paintbrushes (*Castilleja* spp.), lupines (*Lupinus* spp.), and the Yellow Prairie Violet (*Viola nuttallii* Pursh.), together with large butterfly populations. However, the heavily

grazed areas retained very few herbaceous plants or butterflies, and were mostly barren except for the remaining sagebrush.

Human disturbance has been particularly destructive to native ecological communities along the West Coast, and many forms of *Speyeria* have become extinct or are threatened with extinction in this region. A typical example is *S. adiate atossa* (Edwards) 1890. The *atossa* populations were once widely distributed and extremely abundant in the Sierra Madre, Tejon and Tehachapi Mountains of southern California, living on open grasslands where violets such as the Pine Violet (*V. purpurea* Kell.) were abundant (Comstock, 1927). According to Emmel and Emmel (1973), the subspecies is probably completely extinct today, with the last known specimen collected in 1959. It is thought that over-grazing by livestock combined with drought so greatly reduced the larval foodplant that the butterfly could no longer survive (Orsak, 1974).

Suburban growth and development have also been extremely destructive to native violet and *Speyeria* populations, as seen in the San Francisco Bay region. At one time, three very unusual forms of *Speyeria* were endemic to this area. A very dark, melanic form of *S. coronis coronis* Behr once lived in the lowlands on the north side of San Pablo Bay in Napa and Sonoma Counties, and apparently became extinct between 1940 and 1950 (L. Paul Grey, personal communication). At about the same time, the southern pale form of *S. zerene myrtleae* dos Passos & Grey 1945 became extinct in the coastal areas of San Mateo County due to suburban development. The most widely distributed *Speyeria* around San Francisco Bay was the extremely dark, melanic *S. callippe callippe* (Boisduval) 1852, which lived on many of the higher hillsides around the bay. This species is also nearly extinct in the region today, although a few colonies still survive on San Bruno Mountain. New development projects may eliminate these colonies in the near future, resulting in the complete extinction of the once widespread *Speyeria* populations in the San Francisco area.

More widespread exterminations have taken place in the Willamette Valley of western Oregon, where the original native prairie grasslands have been almost completely destroyed due to human disturbances, including extensive agriculture, over-grazing by livestock, and the introduction of rank growing weeds and grasses that have crowded out the native plants. Many of the rarer native plants have become totally extinct in Oregon. For example, a rare yellow flowered Indian paintbrush (*Castilleja levisecta* Greenm.) is only known to survive in one large population near Tenino, Washington, but was once widely distributed from British Columbia through western Oregon (Kenton Chambers, personal communication).

A partial idea of the original flora and insect fauna of the Willamette Valley can be reconstructed through specimen records preserved in the insect and plant collections at Oregon State University. Three different species of violets were apparently widely distributed in the valley

grasslands, including *V. hallii* Gray, *V. howellii* Gray and *V. nuttallii praemorsa* Dougl. Of these, *V. hallii* is apparently completely extinct in the valley and *V. howellii* is nearly extinct. *Viola nuttallii* still survives on a few of the open south-facing hills around the Willamette Valley, but the extensive populations once found on the valley floor have been completely eliminated. Two species of *Speyeria* may have utilized these grassland violets in the past. A large form of *S. callippe elaine* dos Passos & Grey 1945 apparently lived on the valley grasslands, and a few ancient specimens collected near Corvallis between 1897 and 1926 are still preserved in the O.S.U. collection today. *Speyeria zerene bremnerii* (Edwards) 1872 was largely restricted to the foothills around the Willamette Valley, and was widely distributed from the Columbia River south to Lane County near Eugene. The last known specimen of *bremnerii* was collected in 1973 near Corvallis, and this form may also be extinct in western Oregon today.

Fortunately, *S. callippe elaine*, *V. hallii* and *V. nuttallii praemorsa* are still very common in parts of southwestern Oregon in Jackson and Josephine Counties, while *S. zerene bremnerii* and *V. howellii* may still be fairly widespread in western Washington and on Vancouver Island. Of course, additional human developments in these regions could eventually cause the organisms to become extinct throughout their ranges, but they do not appear to be threatened with complete extinction at the present time. However, this is certainly not true of *S. zerene hippolyta* (Edwards) 1879.

### **The Decline and Conservation of *S. zerene hippolyta***

The *hippolyta* subspecies of *S. zerene* is closely related to the inland valley *S. zerene bremnerii*, but it is highly specialized for living in coastal salt-spray meadows and grassy headlands at the edge of the Pacific Ocean. A few populations have also been found living on the open grasslands of high mountains located a few miles inland from the ocean. These salt-spray meadows contain many different native plants including the larval foodplant of *S. zerene hippolyta*, the Common Blue Violet (*Viola adunca* J. E. Smith). In addition to the butterfly and violet, many other native wildflowers grow in this meadow habitat. These include two species of wild orchids (*Habenaria greenii* Jeps. and *Spiranthes romanzoffiana* Cham.), wild strawberry (*Fragaria chiloensis* L.), Indian paintbrush (*Castilleja hispida* var. *litoralis* Pennell), Seaside Daisy (*Erigeron glaucus* Ker.), California Aster (*Aster chilensis* Nees), goldenrod (*Solidago* sp.), and a rare grape fern (*Botrychium multifidum* Gmel.). The most important grasses are short bunch grasses including Red Fescue (*Festuca rubra* L.), Tufted Hairgrass (*Deschampsia cespitosa* L.), and several species of bentgrass (*Agrostis* spp.). Since these grasses do not grow very tall, the other wildflowers including the violets grow easily among the grass without being shaded or crowded out.

At one time, populations of the butterfly were widely distributed in such meadows along the Oregon and Washington coasts. However, these original, native salt-spray meadows have almost completely disappeared today due to such human developments as motels and vacation homes, and due to the ecological succession and invasion of shrubs, trees and tall introduced grasses (orchard and rye grasses) into the meadows that have crowded out the native meadow plants, including the violets.

These natural grasslands are thought to have originated from burning activities by the American Indians, who apparently burned off coastal areas periodically for thousands of years to keep the coast open for their fishing and hunting activities. When European settlers arrived on the Oregon and Washington coasts, they took over the grasslands for livestock pastures, and continued such burning practices until fire prevention regulations curtailed such activities. Without fire to maintain the grasslands against brush and tree invasion, most of the coastal grasslands gradually disappeared to salal and salmonberry brushland or Sitka spruce forest. Historical photographs show that brush and forest have taken over large areas of grassland between Rock Creek and Big Creek in Lane County, Oregon, just during the last 10-20 years. Of course, the native wildflowers and butterflies disappear as the brush and trees invade and crowd out the grasslands.

Even without brush and tree invasion, the native grasslands experience a second ecological problem in the absence of fire. The dead grass leaves from previous years growth do not decay very fast in the coastal environment, and gradually accumulate to form a thick layer of thatch that smothers and crowds out the violets and other wildflowers. This is currently a very serious problem in the meadows between Rock Creek and Big Creek, and was partly responsible for the extinction of the butterfly at Ten Mile Creek a few years ago. If the grasslands were burned off every 5-10 years, this layer of dead thatch would be removed, opening up space for the violets to grow and multiply.

Today, only three large populations of typical *hippolyta* are still known to exist on the central Oregon coast, two on federal land in the Siuslaw National Forest at Rock Creek-Big Creek in Lane County and on Mt. Hebo in Tillamook County, and one on The Nature Conservancy's preserve at Cascade Head in Tillamook County. In addition, two small, weak populations were still surviving near the Camp Rilea military reservation in Clatsop County, Oregon, and on the Long Beach Peninsula near Loomis Lake in Pacific County, Washington at the end of 1982. However, the survival of both populations is currently very precarious due to the threats of ecological succession and human developments. As a result, *S. zerene hippolyta* has been officially listed as a "Threatened Species" in the U.S. Department of the Interior's Endangered Species List, effective October 15, 1980. The U.S. Fish and Wildlife Service in cooperation with the U.S.

Forest Service and The Nature Conservancy is now implementing a management recovery plan to preserve the grassland habitat of *hippolyta*, which will include fire as a management tool.

It should be noted that disjunct and slightly divergent populations of *S. zerene* possibly related to *hippolyta* are also found in high subalpine meadows of the Olympic Mountains in Washington and in coastal Del Norte County, California, north of Crescent City. For management purposes, these are not officially considered to be part of the typical *hippolyta* subspecies. They may represent ancient, relict isolates derived from *hippolyta*, or perhaps independent convergence into a *hippolyta*-like form. A distinctly different *S. zerene* race is found on the southern Oregon coast in Curry County, where it occupies typical salt-spray meadow habitats in the manner of *hippolyta*. These populations, representing an intergrade between *S. zerene behrensii* (Edwards) and *S. zerene gloriosa* Moeck, are thus located between typical *hippolyta* populations to the north in Lane County and the Del Norte County populations to the south. It is probable that these *behrensii-gloriosa* populations are a coastal intrusion from similar inland *S. zerene* populations in the Rogue River valley of Curry County. Unfortunately, the California coastal populations of *S. zerene* are facing the same threats from ecological succession and human developments as the Oregon and Washington *hippolyta* populations. These include the *hippolyta*-like populations of Del Norte County, the coastal *behrensii* populations of Humboldt and Mendocino Counties, and the *myrtleae* populations of Sonoma and Marin Counties.

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